Electric Monopole Transitions between 0^+ States for Nuclei Throughout the Periodic Table

Tibor Kibedi, Ray H. Spear

Australian National University

The fact that electric monopole (E0) transitions between states of the same spin and parity are possible in a nucleus enclosed by electrons is well known. The electric monopole transitions can be associated with important aspects of nuclear structure, including
(i) volume oscillations (i.e. the so-called breathing mode), related to nuclear compressibility,
(ii) nuclear shape changes with effective radii variations (keeping constant the nuclear volume),
(iii) isotopic and isomer shift.
The Coulomb interaction of the nucleons with the electrons of an atomic shell or the Dirac background plays an important role to give rise to E0 transitions. Single photon E0 transitions are strictly forbidden by angular momentum conservation.

In the last decades a large number of experimental studies have been carried out to observe and characterize E0 transitions in atomic nuclei. The dimensionless monopole transition strength parameter, $\rho(E0)$, which carries all the information about the nuclear structure, can be determined from absolute transition rates. The dimensionless ratio of the B(E0) and B(E2) transition rates, $X(E0/E2)$ could be extracted from the experimental E0 and E2 intensities. E0 transitions between non-zero spin states are competing with E2 and M1 multipolarities further complicating the determination of $\rho(E0)$ and $X(E0/E2)$. Unfortunately the sign of $\rho(E0)$ could be determined only in a very few cases, it is customary to use $\rho^2(E0)$.

In this study a critical evaluation of the available experimental data on E0 transitions between 0^+ states, for all even-even nuclei ranging from ${}^4_2\mathrm{He}_2$ to ${}^{250}_{98}\mathrm{Cf}_{152}$ has been carried out. For nearly 300 transitions adopted values of $\rho^2(E0)$, $X(E0/E2)$ and $q^2(E0/E2)$, defined as the ratio of the $I_K(E0)$ and $I_K(E2)$ intensities, have been deduced. In the current analysis the E2 transition to the first excited 2^+ was used to determine $q^2(E0/E2)$ and $X(E0/E2)$. The emerging systematics of E0 transition properties will be compared with the systematics on E2 and E3 transitions.

Email: Tibor.Kibedi@anu.edu.au